Non-Scaling FFAG for US Input Beam: Baseline Parameters

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RF Frequency	201.25 MHz
Transverse normalized acceptance	30 mm
Longitudinal acceptance	150 mm
Particles in train	8×10^{12}
Maximum Energy	20 GeV
Maximum pole tip field	7 T
Drift required for RF	2 m
Drift between quads	50 cm
Excess good field radius	30%

- Lattice is triplet with horizontally defocusing in center

- Magnet apertures are circular

  ◆ Field is not "good" over entire aperture; increase aperture 30% beyond beam size to compensate

- Particles in train corresponds to 4 MW and one sign

- Triplet with all magnets combined function

- Vary magnet lengths, dipole and quadrupole fields to fit constraints (6 parameters)

- Fit low-energy tunes to 0.35 (2 constraints)

- Fit derivative of time-of-flight at central energy to zero (one constraint)

- Fit pole tip fields to maximum value (2 constraints)
  - ◆ Construct smallest circle which encloses minimum energy and maximum energy ellipses
    - ★ May not contain ellipses at intermediate energies, but close
  - ◆ Add "good field" overhead to the circle's radius
  - ◆ Find maximum field on this circle (it's on the midplane)

- Require that $V/(\omega \Delta T \Delta E)$ be a specified value (1 constraint)
  - ◆ ΔT is time-of-flight at minimum energy
  - ◆ Value chosen to give good longitudinal phase space acceptance
  - ◆ Real-estate gradient assumed to be 1.5 MV/m
  - ◆ Value increases for lower energy stages

Minimum Energy (GeV)	2.5	5	10
Maximum Energy	5	10	20
Cells	216	154	150
D-F drift length (cm)	50	50	50
Cavity drift length (cm)	200	200	200
D quad center (mm)	2.23	7.50	8.07
D quad radius (cm)	15.26	10.72	7.97
D quad length (cm)	44.2	53.2	83.4
D quad field (T)	-2.51	2.12	3.07
D quad gradient (T/m)	-29.0	-48.9	-54.8
F quad center (mm)	-6.62	0.21	1.36
F quad radius (cm)	11.02	7.15	5.95
F quad length (cm)	22.5	17.8	29.4
F quad field (T)	3.32	-0.61	-1.58
F quad gradient (T/m)	35.5	89.6	93.2
$V/(\omega \Delta T \Delta E)$	1/6	1/8	1/12
Circumference (m)	840.7	598.8	663.2
RF Voltage (MV)	1261	898	995

- 5–10 GeV about same circumference as 10–20 GeV

    - Lower $V/(\omega \Delta T \Delta E)$ needed for longitudinal acceptance

- Apertures increase going from 10–20 to 5–10 GeV

- Ratio of energy gain to voltage much smaller for 5–10 than 10–20 GeV

- 2.5–5 GeV is ugly

    - Huge circumference: larger than 5–10 GeV

    - Larger $V/(\omega \Delta T \Delta E)$

    - Time-of-flight range dominated by velocity variation

    - Even larger apertures

    - Almost no advantage in having an FFAG: look at voltage

    - Must decide what to do about this

- Choice of $V/(\omega \Delta T \Delta E)$ is still somewhat random

    - Need a procedure to determine more precisely